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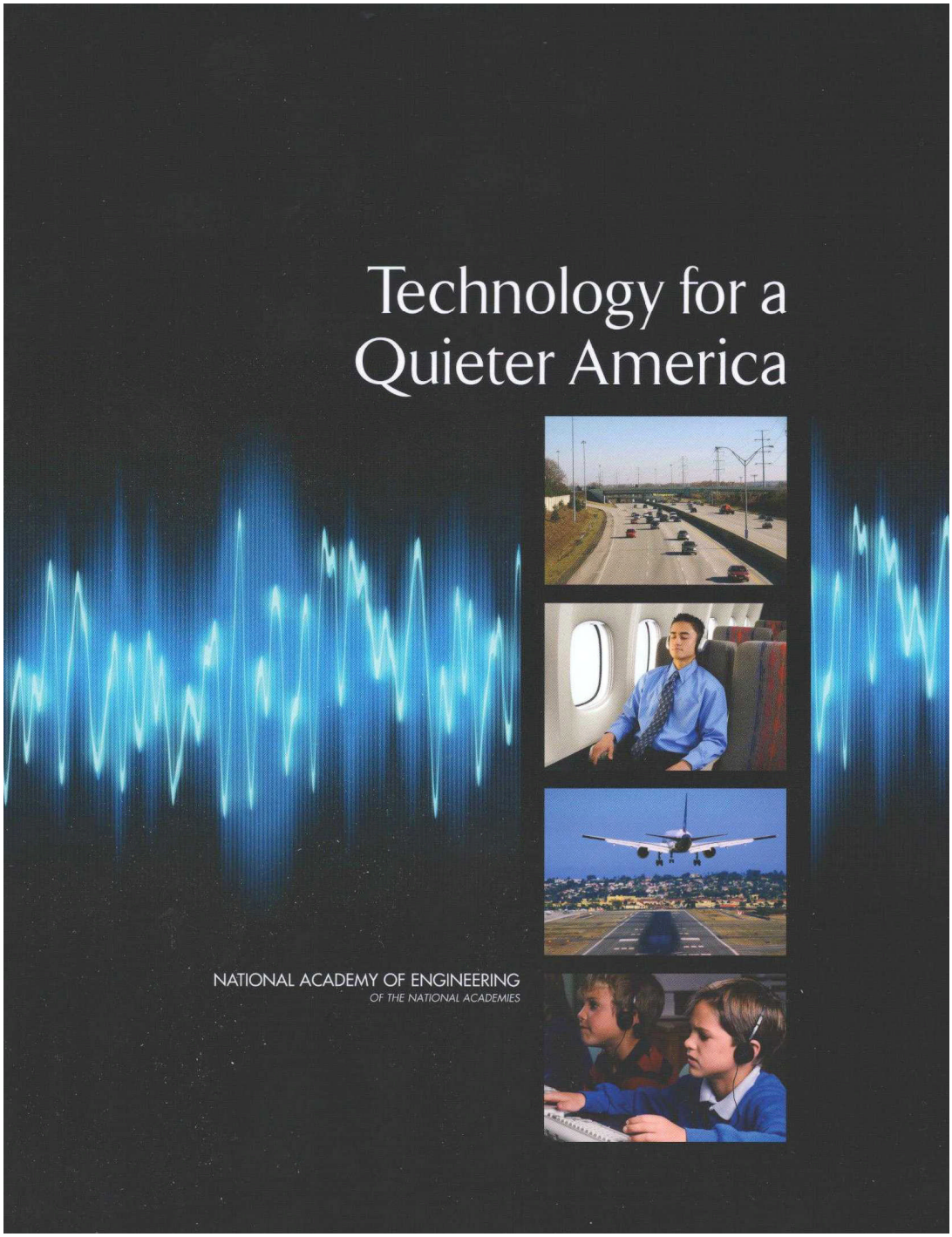

Report Summary

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Preface

Noise emissions are an issue in industry, in communities, in buildings, and during leisure activities. As such, the audience for a report on noise control is broad and includes the engineering community; the public; government at the federal, state, and local levels; private industry; labor unions; and nonprofit organizations. These stakeholders should find something of interest in this report.

In the past few decades advances have been made in noise control technology, instruments for noise measurement, and criteria for noise control. These advances need to be recognized in our approach to the control of noise and public policy designed to improve the noise climate in the United States. This, together with increasing worldwide interest in reducing noise, makes it necessary to examine American interests in the production of low-noise products with a view toward remaining competitive. Reducing product noise emissions and achieving noise reductions in our factories, office buildings, classrooms, homes, and the environment are challenging problems.

This study was undertaken by the National Academy of Engineering (NAE) to emphasize the importance of engineering to the quality of life in America, in particular the role of noise control technology making possible a quieter environment. This report was prepared by a study committee and five supporting panels of experts appointed by the NAE and reviewed by an independent panel appointed following NAE procedures. Implementation of the recommendations in the report will result in reduction of the noise levels to which Americans are exposed and will improve the ability of American industry to compete in world markets where increasing attention is being paid to the noise emissions of products.

Key areas where recommendations have been made include cost-benefit analysis of noise reduction, especially related to road traffic noise; improved metrics for noise control; lower limits for noise exposures in industry; "buy quiet" programs; wider use of international standards for noise emissions; airplane noise reduction technology; and noise control in structures such as schools, hospitals, and office buildings. Also recommended is improved cooperation between industry and government agencies involved with noise and, in particular, an expanded role for the Environmental Protection Agency, which can be undertaken under existing law.

George C. Maling, Jr.
Chair
Committee on Technology for a Quieter America

Executive Summary

Exposure to noise (i.e., unwanted or potentially hazardous sound) at home, at work, while traveling, and during leisure activities is a fact of life for all Americans. At times noise can be loud enough to damage hearing, and at lower levels it can disrupt normal living, affect sleep patterns, affect our ability to concentrate at work, interfere with outdoor recreational activities, and, in some cases, interfere with communications and even cause accidents. Clearly, exposure to excessive noise can affect our quality of life.

As the population of the United States and, indeed, the world increases and developing countries become more industrialized, problems of noise are likely to become more pervasive and lower the quality of life for everyone. Efforts to manage noise exposures, to design quieter buildings, products, equipment, and transportation vehicles, and to provide a regulatory environment that facilitates adequate, cost-effective, sustainable noise controls require our immediate attention. Specific recommendations that address these issues are included in this report.

This report looks at the most commonly identified sources of noise, how they are characterized, efforts that have been made to reduce noise emissions, and efforts to reduce the noise experienced by people in workplaces, schools, recreational environments, and residences. The report also reviews the standards and regulations that govern noise levels and the federal, state, and local agencies that regulate or should regulate noise for the benefit, safety, and wellness of society at large. This report also presents information on the cost-benefit trade-offs between efforts to mitigate noise and the improvements they achieve, information sources available to the public on the dimensions of noise problems and their mitigation, and the need to educate professionals who can deal with these issues.

Ubiquitous sources of noise include all modes of transportation—airplanes, trains, trucks, and automobiles; consumer products, such as lawnmowers, snow blowers, and leaf blowers; and manufacturing machinery in the workplace. Noise levels usually decrease as one moves away from a source, but people living close to the end of a runway or near a high-speed interstate highway cannot escape from highly annoying noise; lawn care equipment can annoy neighbors and at times can be hazardous to the user; and the requirements of operating noisy machinery can make it practically impossible for workers to retreat far enough to escape hazardous noise. Below are specific subjects addressed in this report.

IMPROVEMENT OF ENVIRONMENTAL NOISE METRICS

The committee looked in detail at the state of the technology with regard to noise metrics and concluded that modern advances in our ability to collect, store, and analyze noise data challenge us to reexamine current metrics that were developed in the 1970s or earlier with the objective of developing metrics better related to human response to noise.

HAZARDOUS NOISE AT WORK AND AT HOME

This report also provides information on noise, both occupational and nonoccupational, that can damage hearing. The committee recommends that current U.S. Department of Labor limits on occupational noise exposure be reviewed and changed. Engineering controls should be the primary means of controlling noise, and "buy quiet" programs will assist in the procurement of low-noise machinery and equipment.

TECHNOLOGIES FOR NOISE CONTROL

Technology alone will not solve all noise problems, but problems that *are* amenable to technical solutions can be solved by engineers with appropriate support from economists, psychologists, medical specialists, educators, and many departments in federal, state, and local governments. In this report the committee has made an assessment of transportation noise sources; noise from machinery, equipment, and consumer products that can affect U.S. competitiveness;

noise in the built environment; noise in the community; and hazardous noise. Some areas, such as aircraft noise reduction, have received a great deal of global attention, but other important sources of noise have received less attention, even though they affect many more people.

COST-BENEFIT ANALYSIS FOR NOISE MITIGATION

Cost-benefit analysis for different noise mitigation options is another area considered by the committee, both broadly and in the context of reducing noise generated by interactions between vehicle tires and road surfaces. At highway speeds this tire/road interaction noise dominates noise emissions from vehicles, and efforts are being made to design road surfaces that minimize this noise. The committee recommends that a formal analysis be performed to compare the costs and benefits of using pavement technology for noise reduction with the costs and benefits of installing noise barriers. This cost-benefit analysis would probably be a cooperative effort of the Federal Highway Administration, the Environmental Protection Agency (EPA), and several states. The efforts of the Federal Aviation Administration to develop a cost-benefit approach to analyze noise around airports could help in the development of a similar project to analyze options for reducing highway noise. European cost-benefit analyses, clearly much more extensive than similar American analyses, are also reviewed.

STANDARDS AND REGULATIONS FOR PRODUCT NOISE EMISSIONS

The European Union (EU) has been a leader in the development of noise regulations based on standards promulgated by the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC). These regulations are more extensive than regulations in the United States, and consequently European manufacturers have gained an advantage over their U.S. counterparts in meeting demands for low-noise machinery and other products worldwide.

Regulatory and standards-setting activities regarding noise, especially in the EU, are examined, and their impact on the ability of U.S. manufacturers to compete in world markets is assessed. EU member states have placed significant emphasis on the need for noise emission standards and have exercised waxing influence within the ISO, and to some extent the IEC, on the development of international noise emission standards. Meanwhile, U.S. influence within ISO and IEC on noise-related issues has waned. Building on voluntary standards, noise emissions from consumer products are much more highly regulated in Europe than in the United States, and European requirements on noise levels in the workplace also are more stringent than in the United States. The role of the U.S. Department of Commerce, especially its National Institute of Standards and Technology, is reviewed, and several recommendations are made for strengthening U.S. manufacturers' participation in international standards-setting bodies related to noise control and for improving dissemination of information on noise emission requirements outside the United States.

Although noise requirements can sometimes be a burden, they can also encourage innovation. A manufacturer's desire for the design of a low-noise machine for sale in world markets is a positive force that could lead to the introduction of quiet products into American markets and be an incentive for manufacturers and purchasers to cooperate in "buy-quiet" programs. Indeed, at the time of purchase, consumers rank noise as one of the top five characteristics when comparing product performance. Yet noise levels for U.S. products are often buried in product literature and reported in different noise metrics, making it difficult for consumers to compare noise levels at the time of purchase. Thus, consumers are unable to make informed decisions about the noise emission of a product. This problem could be corrected if product noise levels were prominently displayed and manufacturers adopted a system of self-enforcement.

American manufacturers have the ingenuity to design quiet products. However, manufacturers and trade associations, as well as the voluntary-standards community, have been unable to agree on a uniform standard for measuring and labeling product noise.

THE ROLE OF GOVERNMENT

In some areas—notably aircraft noise, occupational noise, and highway noise that can be reduced by barriers—government regulation has played a major role. But this report shows that improvements can be made in other ways as well. For example, authority for cost-benefit analysis, interagency projects, and dissemination of public information was granted to the EPA by Congress. Because of a lack of funding, however, EPA has been unable to carry out these activities. The study committee recommends changes that will make it easier for the federal government to improve the lives of Americans.

EDUCATION OF NOISE CONTROL ENGINEERS

This report also examines the state of noise control engineering education and concludes that the nation needs to educate specialists in the field and provide basic knowledge of the principles of noise control engineering to individuals trained as specialists in other engineering disciplines.

PUBLIC INFORMATION

An informed public is an important element in efforts to create a quieter America, and the Internet is a low-cost avenue for dissemination of authoritative information on noise, noise control, and the effects of noise on people. The public would

benefit from knowing that there are engineering solutions to many noise problems, and a uniform system of labeling the noise emissions of products would enable the public to make informed purchase decisions. EPA has the authority to do more than it is currently doing to create and disseminate public information, and engineering societies can contribute information on noise reduction that is accessible to the public. Citizens groups can also be a source of public information on noise. Specific recommendations to enhance public information efforts are given in this report.

NOISE AND HEALTH

The general relationship between noise and health is not covered in this report, although new information is becoming available (Babisch, 2008; DEFRA, 2009). However, it will take a multidisciplinary study committee to evaluate these results and determine their relevance to the health of the American people.

CONCLUSION

Reducing the noise levels to which Americans are exposed will require cooperation among engineers, industrial management, and government in many disciplines, and it will not be accomplished in a short time. Nevertheless, reduced noise levels will contribute to improved quality of life for many Americans, and the committee believes that the recommendations in this report, if implemented, will improve the current noise climate.

REFERENCES

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DEFRA (Department for Environment Food and Rural Affairs). 2009. Estimating Dose-Response Relationships between Noise Exposure and Human Health in the UK. BEL Technical Report 2009-02. Available online at *http://www.defra.gov.uk/environment/noise/igcb/healthreport.htm*.

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Summary Findings and Recommendations

This summary has been prepared to give readers a concise view of the contents of the report and the recommendations. Because of the large number of issues covered in this report and the likelihood that some readers may be interested in only one or a few chapters, findings and recommendations are also included in Chapters 3 through 10. The contents of this summary are aligned with the Executive Summary, an even shorter overview; the committee recommends that the Executive Summary be read before the findings and recommendations summarized below.

IMPROVE ENVIRONMENTAL NOISE METRICS

The committee studied the applications and limitations of existing environmental or community noise metrics. The current most widely accepted metric for characterizing the impact of environmental noise, the day-night average sound level[1] (DNL) measured in decibels (dB) has both strengths and weaknesses. Yet the committee agreed that DNL remains a very useful measure for understanding, communicating, and responding to potential noise impacts on communities. Extensive research has shown that a DNL of 65 dB yields a significantly higher fraction of affected populations that are "highly annoyed" (12 to 19 percent) than a DNL of 55 dB (only 3 to 8 percent). Therefore, the committee concludes that there is sufficient evidence to justify reducing the current U.S. federal agency limit on DNL from 65 to 55 dB.

Recommendation 3-1: The federal government (e.g., agencies of the U.S. Department of Transportation with responsibilities related to noise and the U.S. Department of Housing and Urban Development) should adopt as a goal the 1974 recommendation of the Environmental Protection Agency (EPA, 1974) to limit the day-night average sound level (DNL) to 55 decibels (dB) to protect the public health and welfare. Currently, DNL (DENL in Europe), the accepted metric for characterizing the impact of community noise, shows that a large proportion of the population is highly annoyed at a DNL of 65 dB or higher.

Recent advances in the collection, storage, and analysis of noise data have led to a reexamination of the metrics developed in the 1970s or earlier and the development of new community noise metrics that more accurately reflect human responses to noise.

Recommendation 3-2: Relevant agencies of the federal government (e.g., agencies of the U.S. Department of Transportation with responsibilities related to noise, the Environmental Protection Agency, and the U.S. Department of Housing and Urban Development) should fund the development of environmental noise metrics that are more transparent and more reflective of the impact of noise on an affected population than DNL. This will require improved tools for predicting community sound pressure time histories and the development of metrics that accurately reflect the sounds people hear. A more holistic model of annoyance is also needed that incorporates situational variables that can be used to generate predictions for overall response, as well as responses of vulnerable populations (e.g., elderly people, sick people, children, and noise-sensitive individuals). International cooperation in this effort will facilitate the development of national and international standards for calculating metrics and should include open-source code to facilitate broad implementation of the metrics. Certain measures should be taken to facilitate this development:

1. The international noise control engineering community should develop an open, collaborative data-sharing environment in which researchers can deposit and access data from community noise surveys (e.g., data from surveys of acoustic, environmental, community,

[1]The day-night average sound level (DNL) is the average sound level for a 24-hour day, after addition of 10 decibels to levels from midnight to 0700 hours and from 2200 hours (10 p.m.) to midnight.

and transportation systems to support comparisons of metrics and predictions by models).

2. Policy agencies should conduct extensive surveys around at least six U.S. airports to generate high-quality data to populate the database. These surveys should serve as models of good survey practices, including data recording and archiving to ensure that they are useful for future studies.

STRENGTHEN THE REGULATORY FRAMEWORK FOR HAZARDOUS NOISE

This report provides information on both occupational and nonoccupational noise that can damage hearing and assesses the technologies and regulatory framework that address hazardous noise in the workplace. Current U.S. Department of Labor limits on occupational noise exposure are higher than those recommended by EPA, the National Institute of Occupational Safety and Health (NIOSH), and hearing conservation professionals worldwide, as well as current limits written into national and international standards.

Recommendation 4-1: To comply with the recommendation of the National Institute for Occupational Safety and Health, the policy of several other government agencies, and widespread national and international scientific opinion, the U.S. Department of Labor should adopt the 85-dB(A)/3-dB limit for exposure to hazardous noise. This would replace the current 90-dB(A)/5-dB requirement.

With respect to impulsive noise (a single burst or a series of bursts closely spaced or isolated) and its associated auditory hazards, the committee concludes that current damage risk criteria in the United States and internationally are inadequate and need further study.

Recommendation 4-2: The National Institute for Occupational Safety and Health should be the lead agency and should be tasked by its parent agencies (U.S. Department of Health and Human Services/Centers for Disease Control and Prevention) to develop new damage risk criteria with assistance from the military services that have experience with high-amplitude impulsive noise.

PROMOTE THE USE OF ENGINEERING CONTROLS TO REDUCE HAZARDOUS NOISE

The original 1971 Occupational Safety and Health Administration noise regulation for general industry, 29 CFR 1910.95, accorded "engineering controls" (i.e., reducing the noise exposure of workers by reducing the noise of the machinery or equipment that generates the noise) primacy in reducing hazardous noise exposure in the workplace. Reviewing research and experience since the 1971 regulation, the committee concludes that engineering controls, "buy quiet" programs (programs that require or provide incentives for companies and government entities to purchase quieter equipment), or other means that reduce hazardous workplace noise provide significant long-term advantages over the use of individual hearing protection devices (HPDs) in the workplace.

The committee concludes that engineering controls of noise in the workplace should be the primary method of protecting workers from hazardous noise exposure. Accordingly, the committee recommends the following actions by U.S. government agencies, engineering and trade societies, and other stakeholders to promote the development and use of engineering controls.

Recommendation 4-3: The U.S. Department of Labor should revoke the Occupational Safety and Health Administration (OSHA) "100-dB Directive" of 1983, which effectively raised the action point for engineering control of noise from 90 to 100 dB by allowing the substitution of hearing protectors for noise control up to 100 dB and thereby devastated the market for quiet machinery and equipment. At the same time, OSHA should reconfirm that engineering controls should be the primary means of controlling noise in the workplace.

Recommendation 4-4: The National Institute for Occupational Safety and Health and the U.S. Department of Labor should develop and distribute widely an electronic database of noise control problems, solutions, and materials—taking into account the many handbooks and articles devoted to industrial noise control.

Recommendation 4-5: Engineering societies and trade organizations should develop guidelines for defining the relationship between noise emission specifications in terms of sound power level and/or *emission* sound pressure level and noise *immission* levels in industrial situations. They should provide a primer for buyers and sellers of machinery and equipment that includes: descriptions of how noise propagates in rooms; how to determine noise from a large number of machines; standards available to manufacturers and others for measuring noise emissions; and case histories of noise levels measured in *in situ* environments.

Recommendation 4-6: Government agencies should be instructed by a presidential directive or in congressional report language to show leadership in promoting "buy quiet" activities by developing and implementing programs for the purchase of low-noise products, as required by 42 USC 65, Section 4914. American industry should adopt "buy quiet" programs that require noise emission specifications on all new equipment and "declared values" in purchase specifications.

DEVELOP AND DEPLOY TECHNOLOGIES FOR NOISE CONTROL

The committee assessed new technologies in materials and systems for controlling noise from a large variety of sources. There are enormous disparities among programs, facilities, and resources for addressing noises of different types. For example, although engineering tools may be available for reducing aircraft noise and highway noise, the former has been deemed a national priority, while the latter has received less attention. Resources allocated for noise reduction are not always commensurate with noise exposures and impacts.

Aircraft noise control technology is much more advanced than technologies for addressing other noise sources, and the funds expended to reduce the noise of airplanes themselves as well as mitigation measures around airports is far greater than for other noise sources. Road traffic noise has been controlled mostly by constructing noise barriers, but work is being done on promising technologies for reducing noise generated by tire/road interaction. Technologies are available for reducing noise from rail-guided vehicles, and these will become more important as the nation develops light rail systems and high-speed trains. Technologies for the built environment will also become more important as building construction is driven by Leadership in Energy and Environmental Design (LEED) certification and "green" principles. Active controls of sound and vibration have been under development for many years, but few products on the market have incorporated them, and many barriers must still be overcome.

Many tools for designing and developing quieter products have become available in the past few decades, driven largely by increases in computational power and reductions in computational costs. Even so, access to new tools is as uneven as the allocation of resources; corporate budgets for capital equipment are generally tight, and there is competition between departments for available funds. Furthermore, organizations that are doing only routine testing of products according to national and international standards find expensive new tools hard to justify. Thus, even though noise mechanisms in aircraft, automobiles, rapid transit and trains, consumer products, and industrial machinery are fundamentally similar, the availability and application of tools for addressing them are not. The committee recommends that ways be found to give industry and academia access to these tools for the benefit of manufacturers, workers, and the public.

Reducing Aircraft Noise

Recommendation 5-1: The National Aeronautics and Space Administration (NASA) should continue to fund collaborative projects by engine, airframe, and aircraft systems manufacturers. Drawing on expert knowledge in research organizations and academic institutions, research should focus on the complex interrelationships between engine and airframe and the importance of reducing each constituent noise source to reduce the overall noise signature of aircraft. These projects should develop improved prediction tools, for example, for advanced propulsion designs; acoustic scattering and propagation models, including weather and terrain models; models of the effects of interactions between engine installation and airframe configuration; and benchmark measurements necessary for the development and validation of these advanced tools.

Recommendation 5-2: The Federal Aviation Administration should continue to fund the development of novel operational and air traffic management procedures to minimize noise and should work with NASA and industry to make intelligent trade-offs between competing noise mitigation and chemical pollution goals.

Reducing Road Traffic Noise

Recommendation 5-3: Current activities of the Federal Highway Administration and several states to investigate noise reduction through new pavement design should be continued and expanded to speed up development and application of new technologies. Studies on the durability of pavement surfaces are essential, because durability has a direct effect on the life-cycle costs of applying quiet pavement technology, which has the potential to reduce noise where barriers are not feasible—for example, where homes are located on a hillside overlooking a busy highway.

Reducing Rail Noise

Recommendation 5-4: Planning tools available from modal agencies of the U.S. Department of Transportation, such as the Federal Railroad Administration and the Federal Transit Administration, should be used in planning new rail transportation systems, and supplemental metrics should be developed and used to estimate the effects of noise on people. The public would benefit if warning horns were made more directional; research and development related to warning horn directivity should be undertaken to better understand the effects on safety and benefits to the public.

Reducing Noise in Buildings

Recommendation 5-5: The acoustics and noise control communities should actively promote the inclusion of noise criteria in requirements for Leadership in Energy and Environmental Design (LEED) certification of buildings, not only to improve the noise environment but also to ensure that the acoustical environment is not degraded. Design standards (e.g., building codes) must be improved to ensure

that good acoustical practices are followed in the construction of buildings.

Recommendation 5-6: The National Institutes of Health and/or the Facilities Guidelines Institute should fund the development of improved materials for hospital environments, where traditionally used materials may harbor and promote the growth of bacteria and other harmful biological agents.

Advancing Active Noise Control

Recommendation 5-7: Research agencies should fund university research on active noise control to address situations where the use of traditional noise-control materials is problematic or where they are not suitable for attenuating noise in the appropriate frequency range. Investigations into hybrid active-passive and adaptive-passive noise control systems and the development of low-cost microphones and loudspeakers that can be used in hostile environments should also be funded.

DEVELOP PRODUCT NOISE EMISSION STANDARDS AND REGULATIONS

The need for noise emission standards is recognized worldwide, especially in the European Union (EU). This need has made the International Organization for Standardization, and to some extent the International Electrotechnical Commission, leaders in the standards community. ISO standards committees have superseded many American-based standards committees and organizations that U.S. manufacturers have relied on in the past. America's voice on the ISO standards committees is weakened by the lack of U.S. manufacturers' leadership in ISO working groups. America has only a single vote, the same as every member country in the EU.

The EU has been a leader in the development of noise regulations based on these standards. These regulations are more extensive than those that exist in the United States, and consequently European manufacturers have gained a competitive advantage over their U.S. counterparts in meeting demand for low-noise machinery and other products worldwide. It is important to note that, although more stringent noise requirements can sometimes be a burden for manufacturers, they can also encourage innovation. A manufacturer's desire to design a low-noise machine for sale in world markets is a positive force that could lead to the introduction of quiet products into American markets and provide an incentive for manufacturers and purchasers to cooperate in "buy quiet" programs.

At the time of purchase, consumers rank noise as one of the top five characteristics when comparing product performance. Other concerns are energy efficiency, cost, reliability, and serviceability. Noise levels for U.S. products are often buried in product literature and reported using different noise metrics, making it difficult for consumers to compare noise levels at the time of purchase. Thus, consumers are unable to make informed decisions on the noise emission of a product. This problem could be corrected if product noise levels were prominently displayed and manufacturers adopted a system of self-enforcement.

American manufacturers have the ingenuity to design quiet products. However, manufacturers and trade associations, as well as the voluntary standards community, have been unable to agree on a uniform standard for measuring and labeling product noise.

Recommendation 6-1: The Environmental Protection Agency should encourage and fund the development of a uniform system of labeling product noise. The system should be self-enforced by manufacturers but should have strict rules and penalties if products are deliberately mislabeled. The rules should specify standard methodologies for measuring product noise. Uncertainties in noise emission values should be acknowledged. Product noise labels should be prominently displayed so that consumers can make informed purchasing decisions. In a world with proliferating eco-labels and different requirements, international cooperation to develop one label recognized worldwide would be of great benefit to American manufacturers and consumers everywhere.

Recommendation 6-2: Government, trade associations, and industry should fund the participation of U.S. technical experts on standards bodies that develop international standards for determining product noise emissions.

Recommendation 6-3: The National Institute of Standards and Technology should take the lead in providing assistance to American manufacturers with noise regulation compliance by establishing a database of information on U.S. and international product noise emission standards and requirements.

Recommendation 6-4: To establish their credibility, organizations that determine noise emission data according to a certain standard as part of a voluntary labeling program should be accredited to test products. Managers at the National Institute of Standards and Technology and its National Voluntary Laboratory Accreditation Program should promote their accreditation program, especially in industrial laboratories.

USE COST-BENEFIT ANALYSIS AS A TOOL FOR NOISE MITIGATION

The committee considered cost-benefit analysis for different noise mitigation options in a broad context and in the specific context of reducing noise generated by interactions

between vehicle tires and road surfaces. At highway speeds this tire/road interaction noise dominates noise emissions from vehicles, and efforts are being made to design road surfaces and tires that minimize this noise. The efforts of the Federal Aviation Administration to develop a cost-benefit approach to analyze noise around airports could help in the development of a similar project to analyze options for reducing highway noise.

Recommendation 7-1: A formal cost-benefit analysis should be performed to compare the costs and benefits of using pavement technology for noise reduction with the costs and benefits of installing noise barriers. This cost-benefit analysis should be a cooperative effort of the Federal Highway Administration, U.S. Environmental Protection Agency, and the several states with technology programs in road surface design. Inputs to the analysis should include data from analyses of noise reduction efforts around airports.

STRENGTHEN THE ROLE OF GOVERNMENT

In some areas—notably aircraft noise, occupational noise, and highway noise that can be reduced by barriers—government regulation has been instrumental in reducing noise. But this report shows that improvements can be made in other ways as well. For example, authority for cost-benefit analyses, interagency projects, and the dissemination of public information on noise was given to the EPA by Congress. Because of a lack of funding, however, EPA has been unable to carry out these activities. The study committee recommends changes that will make it easier for the federal government to improve the nation's noise climate and with it the lives of American citizens.

Recommendation 8-1: The Environmental Protection Agency should carry out its coordinating function under 42 USC 65, Section 4903. The agencies with noise-related activities include the U.S. Department of Defense, U.S. Department of Transportation, U.S. Department of Labor, U.S. Department of Commerce, U.S. Department of Health and Human Services, U.S. Department of Housing and Urban Development, and the National Science Foundation.

Recommendation 8-2: Congress should pass legislation and provide the necessary funds to establish the Environmental Protection Agency as the lead agency in the development of a cooperative effort on noise measurement, abatement, and control involving federal agencies, state governments, industry, consulting firms, and academia. An EPA office should implement 42 USC 65, Section 4903, and the legislation should expand the authority already given by Congress to ensure that the agency can effectively manage a program to meet the following objectives:

- coordination and cooperation among existing interagency groups concerned with noise
- clear delineation of the roles of federal agencies, as well as state and local governments
- assisting American industry in lowering noise levels in the U.S. workplace and developing industrial and consumer products with noise emissions that are competitive with foreign products
- development of international standards for the measurement and labeling of noise emissions
- active U.S. participation in the harmonization of noise emission requirements worldwide
- development of metrics for environmental noise that truly represent community response to noise
- ongoing assessment of the costs and benefits of noise control
- increased research on the health effects of noise, especially nonauditory effects

EDUCATE MORE NOISE CONTROL ENGINEERS

The committee reviewed the state of noise control engineering education in the United States and concludes that the nation must educate more specialists in the field and provide basic knowledge of the principles of noise control engineering to individuals trained as specialists in other engineering disciplines. Undergraduate education in noise engineering varies greatly from institution to institution, both in terms of the department in which it is housed and in the courses offered. Funding for noise control engineering programs at universities is problematic, and support for graduate students to assist in research (or teaching) and to develop a new cadre of professionals is inadequate.

The multidisciplinary nature of noise control engineering poses challenges for engineering practice and for lifelong learning. Elements of noise control engineering degree programs should be formally taught by faculty in academic units or departments (in engineering, physical sciences, and architecture) in an intra- or interdisciplinary way. Major professional societies (such as American Institute of Aeronautics and Astronautics, American Society of Mechanical Engineering, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Institute of Noise Control Engineering of the USA, Society of Automotive Engineers) and other stakeholders should organize symposia (or special sessions in regular conferences) where leading academic and industry leaders can propose and refine curricula and suggest improvements in teaching methods and delivery mechanisms. Collaboration among academic, research, and industry leaders will be necessary for the development of interesting case studies or practice modules that could then be disseminated to teachers of undergraduate courses.

Funding is particularly important for research on environmental noise, which encourages interdisciplinary col-

laboration between acousticians, engineers, social scientists, psychologists, sociologists, and medical scientists to develop new metrics for evaluating the impact of noise, including annoyance, speech and communications interference, cognitive impairment, sleep disturbance, and health effects.

Recommendation 9-1: Academic institutions should offer an undergraduate course in noise control engineering, broaden the scope of the engineering curriculum, and increase the pool of engineering graduates who are equipped to design for low-noise emissions. The course could be offered as an elective in a bachelor's degree program or as part of a minor (e.g., in acoustics or interdisciplinary studies).

Recommendation 9-2: Graduate-level noise control courses should provide a balance between theory and engineering practice without sacrificing academic rigor. The committee strongly encourages the establishment of graduate internships in industry and government agencies and thesis research programs to motivate students and to build a cadre of future noise control engineers.

Recommendation 9-3: Federal agencies, private companies, and foundations with a stake in noise control should provide financial support for graduate students who assist in research on, and the teaching of, noise control engineering. This support is crucial for the development of noise control professionals and noise control educators.

IMPROVE PUBLIC INFORMATION ON THE EFFECTS OF NOISE AND NOISE CONTROL

The U.S. Code (42 U.S.C. Section 4913) requires that EPA "develop and disseminate information and educational materials to all segments of the public on the public health and other effects of noise and the most effective means for noise control, through the use of materials for school curricula, volunteer organizations, radio and television programs, publication, and other means." At this time, however, EPA does not have the internal resources to create a large public information program, and it is likely that much of the effort will have to be done through contractors.

The labeling of product noise emission levels should be a critical aspect of a program designed to benefit the public and enable people to make informed purchasing decisions. Although EPA has labeling authority, it is more practical for professional organizations, trade associations, and standards organizations to develop labeling methodology for specific products because of the wide variety of products and noise measurement methods.

Recommendation 10-1: The Environmental Protection Agency should take the following actions under the authority of 42 USC 65, Section 4913, to improve public information and education on the effects of noise and the most effective means of controlling noise:

- Conduct a survey of all activities by federal agencies related to noise, and publish URLs that provide information of interest to the public.
- Develop a categorized list of stakeholders with interests in noise (e.g., professional societies, scientific societies, citizens groups).
- Help organize a coalition of current stakeholders with the goal of improving the availability of information on noise to the public.
- Develop educational materials to inform the public of the health effects of noise, especially noise-induced hearing loss and cardiovascular effects.
- Develop information to help the public understand the benefits of using personal hearing protection devices.
- Provide information on the selection and use of hearing protection devices, making intelligent decisions about frequenting high noise exposure events, the importance of reducing noise exposures by buying quieter products, and being vigilant and active in public policy decision making about community noise zoning issues.

Recommendation 10-2: Engineering professional societies such as the American Institute of Aeronautics and Astronautics, the American Society of Mechanical Engineering, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Society of Automotive Engineers, and Institute of Noise Control Engineering of the USA should develop engineering information on noise control to help the public understand techniques for reducing noise emissions.

REFERENCE

EPA (U.S. Environmental Protection Agency). 1974. Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. Document 550/9-74-004. Available online at *http://www.nonoise.org/library/levels74/levels74.htm*.